# VENUS SURFACE SAMPLE RETURN

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In cooperation with NASA's Solar System Exploration Subcommittee (SSES) the Jet Propulsion Laboratory (JPL) is conducting a series of studies to assess the feasibility of planetary science missions proposed for launch in the 2006-2010 time frame and to prioritize technology development steps that will enable these missions. Until recently the return of sample material from the surface of Venus was widely considered to be beyond the technological and financial capabilities of the NASA Space Science Program for this time frame, but technological and programmatic advances may now have brought such a mission within our reach. This paper will describe the results of a study to investigate the feasibility of various options proposed for a Venus Surface Sample Return (VSSR) Mission and to develop a mission concept to be considered in NASA's strategic planning. Included will be discussions of the science objectives, the major system and subsystem trade-offs, and a preliminary mission concept.

The principal science objective of the mission would be to return samples of surface and atmospheric material to Earth for detailed chemical analysis. Our knowledge of the surface chemistry of Venus is based on a limited number of elemental analyses done by the Venera landers. We have no data on surface mineralogy, which would provide significant constraints on models of evolution of the venusian crust. We have no idea of the volatile content of the rocks: how much water is contained in Venus surface samples would help constrain models of the evolution of the Venus atmosphere and interior. Even more importantly, the venusian impact crater population is distributed randomly, preventing us from determining the ages of surface units.

Returning a sample of the venusian atmosphere is also of extremely high scientific priority. More detailed analyses of the atmospheric chemistry, in particular the isotopic composition, utilizing the more sophisticated laboratory equipment available on Earth would enable us to better address the nature and evolution of the venusian atmospheric greenhouse. In addition, we have little knowledge of the chemical composition of the lower atmosphere of Venus. The lower atmosphere is a key link between surface and interior processes; understanding the detailed composition of the lower atmosphere can help constrain the current reactions taking place between the surface and atmosphere, as well as address fundamental outstanding questions on the volcanic history of the planet.

Venus sample return missions have been proposed in the past, but a number of current developments have provided or will provide substantial additions to the technology base needed to assure success of such a proposal. In addition to the heritage provided by the Mariner, Venera and Vega missions of the 70s and 80s, a VSSR mission in the next decade will benefit from the understanding of the planet and particularly of aeroassist possibilities provided by Magellan, from the development of many elements of a planetary sample return mission by the NASA/CNES Mars Sample Return (MSR) Project (including ascent vehicle, orbiter, rendezvous and docking system and Earth entry vehicle), from extensive Venus balloon technology development work at JPL and elsewhere, and from the general trend toward smaller lighter spacecraft systems.

The paper will describe the results of trade studies for the following elements of the VSSR mission:

- Launch vehicle/spacecraft propulsion: Solar electric propulsion was selected for Earth return;

- Entry/descent/landing: How to make best use of the Magellan experience for aerobraking and/or aerocapture of an orbiter element;

- Surface operations: Sample selectivity and documentation of context traded off against cost and complexity of operating for any significant length of time on the surface (700 K, 90 bar);

- Ascent/rendezvous/docking/sample transfer: Various combinations of balloons, blimps, airplanes, and rockets have been proposed over the years and these have been reevaluated taking into account current and projected technology development in each area. Tolerance of the surface environment by the landed element of the ascent system is a key factor.

- Earth return/Earth entry: Reuse of Mars and/or Stardust systems is cost effective here.

The baseline mission profile includes:

- A single launch of all elements using conventional propulsion;

- Orbiter aerocapture into Venus orbit;

- Lander descent using ballute and parachute, landing site selected using Magellan data, landed element includes ascent balloon and ascent rocket;

- Quick grab samples (90 minutes on the surface);

- Balloon ascent to 60 km;

- Rocket ascent to orbit;

- Rendezvous, sample transfer, Earth return similar to Mars 03/05 mission.